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(54) IMPROVED COOLING PROCESS FOR METAL
 WIRE OR ROD

(71) We, DEMAG AKTIENGESELL-
 SCHAFT, a Body Corporate organised
 under the laws of the Federal Republic of
 Germany, of 4100 Duisburg, Wolfgang
 Reuter Platz, Germany, do hereby declare
 the invention, for which we pray that a
 patent may be granted to us, and the
 method by which it is to be performed, to
 be particularly described in and by the
 following statement:—

This invention relates to a method of
 cooling hot metal wire or rod leaving the
 final stand of a rolling mill.

The process used to cool metal wire or
 rod after it has been hot rolled affects its
 quality and is also of economic significance.
 Various different cooling processes are
 currently in use or have been proposed but
 suffer from one disadvantage or another.
 Thus, one type of process may cool the wire
 or rod insufficiently during the time
 available, another may cool the wire or rod
 irregularly, while yet another may result in
 undesirable changes in the structural
 composition of the metal.

The present invention seeks to overcome
 these drawbacks and starts from the
 realisation that cooling of hot wire or rod
 leaving a rolling mill should be carried out
 intermittently so that short cooling phases
 are interspersed with phases during which
 equalisation of the temperature of the stock
 can take place, the overall cooling process
 being carried out rapidly, but not too
 rapidly, so that scale formation is limited
 while the structure consists of ferrite and a
 preponderant quantity of pearlite.

According to one aspect of the present
 invention, there is provided a method of
 cooling hot metal wire or rod leaving the
 final stand of a rolling mill, wherein the wire
 or rod is wound under tension into a coil
 composed of a plurality of superimposed
 layers of turns, the innermost layer of the
 coil being supported during winding; the
 winding operation being carried out by
 rotating the coil about its axis: the cooling
 operation being carried out using liquid

coolant in such a way that each segment of
 each turn of the coil is subjected alternately
 to a cooling phase (wherein it is subjected
 to the action of coolant) and a temperature
 equalisation phase.

In this way, the wire or rod (hereinafter
 referred to for convenience as "stock")
 wound onto the drum is cooled
 intermittently, that is to say, the stock
 includes zones which are being subjected to
 forced cooling with the aid of coolant,
 alternating with zones which are being
 allowed to cool naturally in air. This results
 in the stock near the surface of the coil
 which has been cooled being reheated by
 the heat escaping from within the cross-
 section, so that a temperature equalisation
 occurs across the cross-section of the stock.
 The resulting cooling process is
 substantially uniform throughout the whole
 thickness, the cooling time is short, the
 structure as desired and, most important,
 scale formation is reduced, such scale as
 does form being removable more easily.

The process may be carried out with the
 aid of a reeling drum which rotates about a
 horizontal axis, the stock wound onto the
 drum being cooled at several spaced
 positions around its periphery. The stock is
 fed onto the drum by a traversing laying
 guide which forms a complete layer along
 the length of the drum before a second
 layer is commenced. The coiling operation
 is controlled to ensure that the spacing, if
 any, between the turns in each layer
 accords with the desired cooling conditions.
 In other words, depending upon the density
 of the consecutive turns partial cooling of
 the layer previously wound may take place
 while the turns in the outermost layer are
 being cooled.

Cooling may be carried out using a
 system of spray heads or discharge nozzles,
 which may be mounted spaced apart on a
 beam which extends along the length of the
 drum, the spray heads or discharge nozzles
 being located at a predetermined distance

from the surface of the outermost layer of the coiled stock.

5 A mechanism may be provided for moving the beam in the direction radially of the drum to ensure that this predetermined spacing remains constant. Coolant may be discharged continuously throughout the reeling operation and the spray heads are arranged to ensure that the spray pattern 10 which is laid down on the surface of the coil extends around a predetermined circumferential extent of the coil. Each transverse segment taken through the stock wound onto the drum therefore passes 15 repeatedly through the spray pattern, during which time it is subjected to a cooling phase, and is alternately open to the free air, during which time a temperature equalisation phase takes place. The 20 respective sizes of these cooling and equalising zones around the circumference of the coil are chosen in accordance with the diameter and quality of the stock being coiled.

25 Carrying out the process described above may result in a non-uniform cooling of the stock because of differences between the cooling times of the individual turns. Furthermore, the lengths of cooling phases 30 may be too great in comparison with the lengths of the intervening equalisation phases so that the stock is cooled at a rate below that desired to obtain the preferred structure. This problem may be overcome 35 by providing a row of individually operable spray heads arranged along the length of the beam. The spray heads may be operated so that only the newly wound turn is subjected to cooling at any instant. In other 40 words, the cooling operation progresses along the coil at the same rate as coiling takes place. When winding of a second layer begins, the cooling operation progresses along the coil in the reverse 45 direction. Without precautions being taken, this procedure would result at the point of reversal of the underlying layer being given a double cooling time without a corresponding doubling of the equalising time (effected only by rotation along the 50 periphery). The cooling effect of the appropriate spray nozzle head may be so rated as not to cause a temperature drop under point of austenite formation nor a 55 drop under any other critical temperature.

When the diameter and quality of the stock permits a quicker change from the cooling to the equalising phase than is obtainable by the method of cooling 60 described above, it may be performed concurrently along several sections of the length of the drum. In addition, several beams equipped with spray heads may be provided around the periphery of the drum 65 so that cooling may be effected at different

rates at different positions around the circumference of the drum. In this connection, the spray pattern formed by the spray heads provided on the various beams may overlap so that repeated cooling of one and the same layer take place. 70

Uniform cooling can also be achieved by arranging several beams equipped with spray heads around the drum circumference, the spray heads being made 75 to operate on completion of a wound layer of stock, and briefly to carry out cooling during one or more revolutions of the drum. In other words, the cooling phase commences when the direction in which 80 winding is taking place is reversed, and the equalisation phase commences when a new layer begins to be wound onto the drum.

Accordingly, it will be seen that a second 85 aspect of the invention provides a method of cooling hot metal wire or rod leaving the final stand of a rolling mill, wherein the wire or rod is wound under tension into a coil composed of a plurality of superimposed 90 layers of turns, the innermost layer of the coil being supported during winding; the winding operating being carried out by rotating the coil about its axis, the cooling operation being carried out using liquid 95 coolant applied to the coil either (a) in one or more regions of each layer of turns, the or each region advancing axially of the coil and keeping pace with the winding operation, or (b) throughout the entire 100 length of the coil after the winding of each layer has been completed.

Instead of spraying coolant onto the coil being built up on the drum, the invention 105 may be performed by partially immersing the drum in a bath of coolant, and rotating the drum about a horizontal axis. With this arrangement, the stock wound onto the drum repeatedly passes through the coolant, so that cooling and equalising 110 phases alternate. The length of the cooling phases may be varied by adjusting the depth to which the coil is immersed. The cooling effect can be adjusted by varying the volume of coolant supplied per unit area or 115 unit of time from a minimum to a maximum or vice versa.

Regardless of how it is performed, the process provided by the present invention 120 takes place in such a way that after the stock has been cooled by sprays of coolant or complete immersion in coolant, the surface zone of the coil is reheated by heat flowing from within. In this way, the uniform cooling action is obtained across 125 the cross-section of the stock until the desired temperature is reached.

Should it not prove possible to completely cool the stock during coiling, 130 that is, because the temperature of the coil remains too high following the period of

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time during which the coil is permitted to remain at the cooling station, cooling of the coil at an accelerated rate can be carried out in one or more further cooling stations to which the coil is transferred from the first cooling station.

Once the structure of the steel has been transformed to that desired, a continuous water cooling process can be carried out provided that the steel is of a type which is not liable to crack, so that the required final temperature can be achieved as soon as possible.

The invention also provides a device for carrying out the method comprising a rotatably drivable winding drum or mandrel and a winding head for the wire or rod, the head being displaceable parallel to the axis of the drum or mandrel, and either one or more tubular beams which are disposed at a specific radial distance from the winding drum or mandrel and displaceable parallel to the axis of same, the or each beam having nozzles for spraying a coolant towards the drum or mandrel, or a container for a coolant into which a coil on the drum or mandrel can be partially and/or temporarily immersed.

The invention will now be described in greater detail but by way of example only with reference to the accompanying drawings, in which:—

Figure 1 is a transformation diagram shown the temperature/time curves for a process carried out in accordance with the present invention and various known processes;

Figure 2 is a diagrammatic side elevation of a device for use in carrying out the process in accordance with the present invention, with one side of a coolant collecting trough removed;

Figure 3 is a plan view of the device shown in Figure 2;

Figure 4 is an end view of the device shown in Figures 2 and 3, and

Figure 5 is a view similar to Figure 4 but showing a modification in which cooling is carried out by immersing the coil in a bath of liquid coolant.

Figure 1 is a transformation diagram (temperature against time) for a given grade of steel. The upper descending curve marked in chain lines represents a cooling process which takes place when the steel is exposed to still air, the lower descending dashed curves show processes carried out when the steel is subjected to a continuous cooling process using a liquid coolant, while the two descending curves drawn in solid lines represent a cooling process carried out in the manner to be described herein.

It will be seen that when cooling takes place with air as the cooling medium, the undesired austenitic structure does not

form but the cooling process itself is too prolonged to be economically desirable. When the steel is cooled continuously using a liquid coolant, the length of the cooling process is short but the transformation curve passes through the zone in which the undesired austenitic structure forms. With the process in accordance with the invention, however, the overall length of the process is substantially reduced but the transformation curve lies outside the austenitic zone so that the finished steel has a predominantly pearlitic structure. The upper of the solid curves designates the temperature at the core of the stock while the lower curve designates the surface temperature.

Referring now to Figures 2 to 4, a cooling apparatus comprises a reeler 1 having a coiling drum or mandrel 2 to which wire 3 is fed from a traversable winding head 4 to form a coil 5. The winding head 4 repeatedly traverses from one end to the drum and then back again so that thin steel stock in the form of wire or rod is laid down in superimposed layers as is more clearly seen in Figure 3. The lower part of the coil is enclosed within a vessel or trough 6, only half of which is shown in the drawings and within which is mounted at least one (in the illustrated case, three) hollow beams or tubes 7 which extend alongside the drum and are provided with nozzles 8 for the discharge of liquid coolant, particularly water "M" supplied to the interior of the beams. The nozzles discharge the coolant in the form of sprays 9 which fan out to impinge in the form of elongate spray patterns of limited circumferential extent on the outer surface of the coil. The liquid collects at 10 in the trough 6. As described above, the position of the beams relative to the axes of the drum may be adjustable and the discharge from individual nozzles or groups of nozzles may be controlled so that the circumferential extent and/or intensity of coolant in a part of the spray pattern is adjustable. The beams 7 are displaceable by means not shown so that the distance between the nozzles 7 and the outer surface of the coil remains constant at a distance "J".

In operation the stock is sprayed while it is wound onto the drum and it will be appreciated that each segment of stock is subjected repeatedly and alternately to cooling and temperature equalization phases from the moment it has been wound onto the drum until it is covered by a subsequent layer, the equalisation phase taking place during the time that the segment passes from one spray pattern to the next. Assuming that an adequate space is left between adjacent turns, the underlying layers also experience these phases.

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During the equalisation phases the heat within the stock flows outwards to reheat the surface of the stock and ensure a uniform cooling.

5 In the modification shown in Figure 5, the spray nozzles are dispensed with and the cooling phase is brought about by immersing the lower part 12 of the coil partially in a bath of coolant 11 contained in the trough or vessel 6. Each segment of the coil is as before subjected to alternate cooling and equalisation phases. The stock may be wound onto the drum sufficiently loosely to ensure that the underlying layers are also subjected to the cooling effect of the coolant.

10 The cooling action may be varied by providing a greater or lesser number of beams 7, by varying the quantity of coolant discharged or by adjusting the depth of immersion of the coil into the coolant in the case of the embodiment shown in Figure 5, whereby the process can be varied at will to suit the process requirements.

25 WHAT WE CLAIM IS:—

1. A method of cooling hot metal wire or rod leaving the final stand of a rolling mill, wherein the wire or rod is wound under tension into a coil composed of a plurality of superimposed layers of turns, the innermost layer of the coil being supported during winding; the winding operation being carried out by rotating the coil about its axis, the cooling operation being carried out using liquid coolant applied to the coil, either (a) in one or more regions of each layer of turns, the or each region advancing axially of the coil and keeping pace with the winding operation, or (b) throughout the entire length of the coil after the winding of each layer has been completed.

2. A method as claimed in any preceding claim, wherein the wire or rod is wound onto a drum rotating about a horizontal axis.

3. A method as claimed in claim 1 or claim 2, wherein cooling is carried out at predetermined spacings around the winding drum circumference.

4. A method as claimed in any preceding claim, wherein the spacing between the turns wound onto the drum is adjusted in accordance with the desired cooling conditions.

5. A method of cooling hot metal wire or rod leaving the final stand of a rolling mill, wherein the wire or rod is wound under tension into a coil composed of a plurality of superimposed layers of turns, the innermost layer of the coil being supported during winding; the winding operation being carried out by rotating the coil about its axis; the cooling operation being carried out using liquid coolant in such a way that each segment of each turn of the coil is subjected alternately to a cooling phase (which it is subjected to the action of coolant) and a temperature equalisation phase.

6. A device for carrying out the method according to any preceding claim, comprising a rotatably drivable winding drum or mandrel, and a winding head for the wire or rod, the head being displaceable parallel to the axis of the drum or mandrel, and either one or more tubular beams which are disposed at a specific radial distance from the winding drum or mandrel and displaceable parallel to the axis of same, the or each beam having nozzles for spraying a coolant towards the drum or mandrel, or a container for a coolant into which a coil on the drum or mandrel can be partially and/or temporarily immersed.

7. A device according to claim 6, characterised in that the beam or each beam is provided with a row of individually operable spray heads.

8. A method as claimed in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

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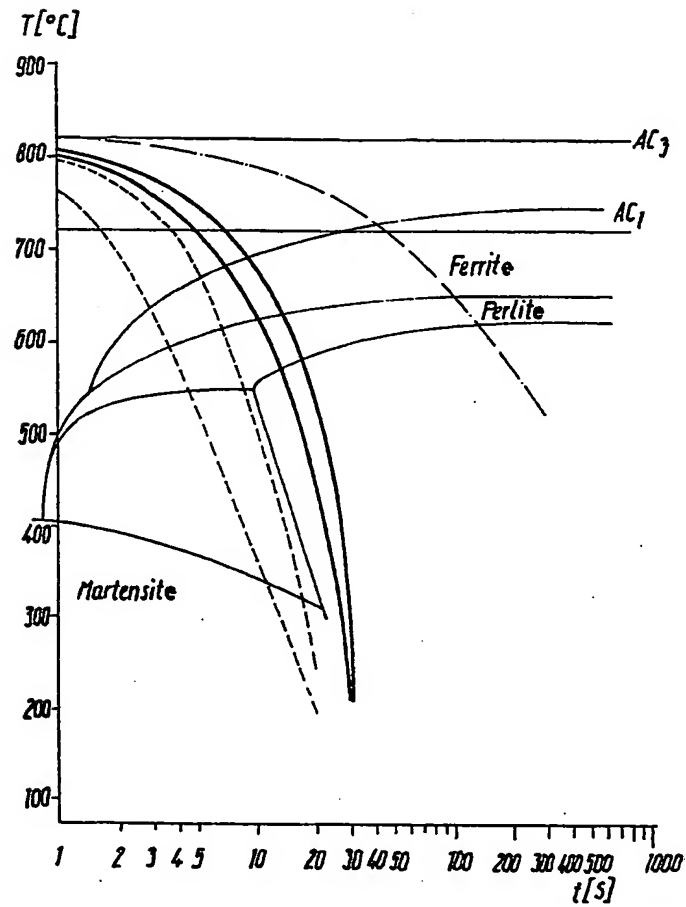


Fig. 1

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